

*wafer stage*

Figure 2 Typical optical verniers

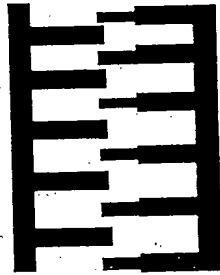
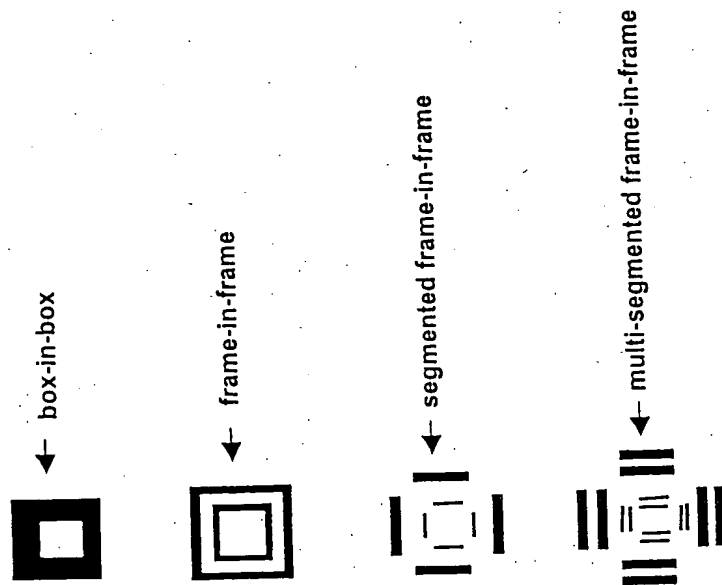


Figure 1 Typical overlay patterns or completed alignment attributes



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Figure 4 Overlapped male and female target pairs

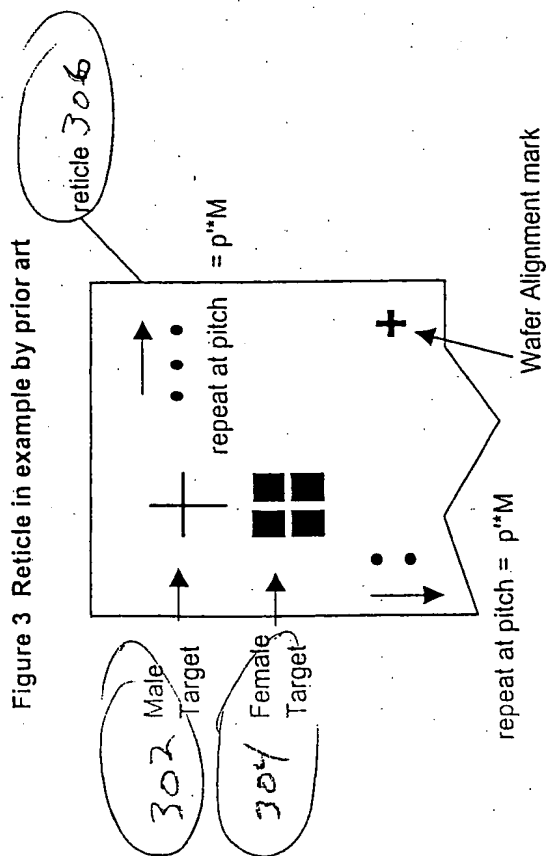
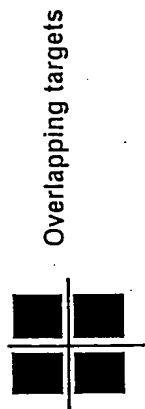


Figure 6 Features of figure 5 in developed positive photoresist

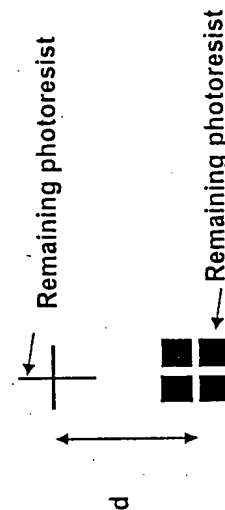
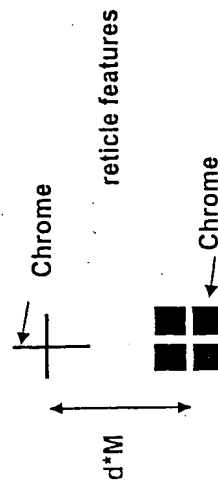


Figure 5 Detail of reticle of figure 3



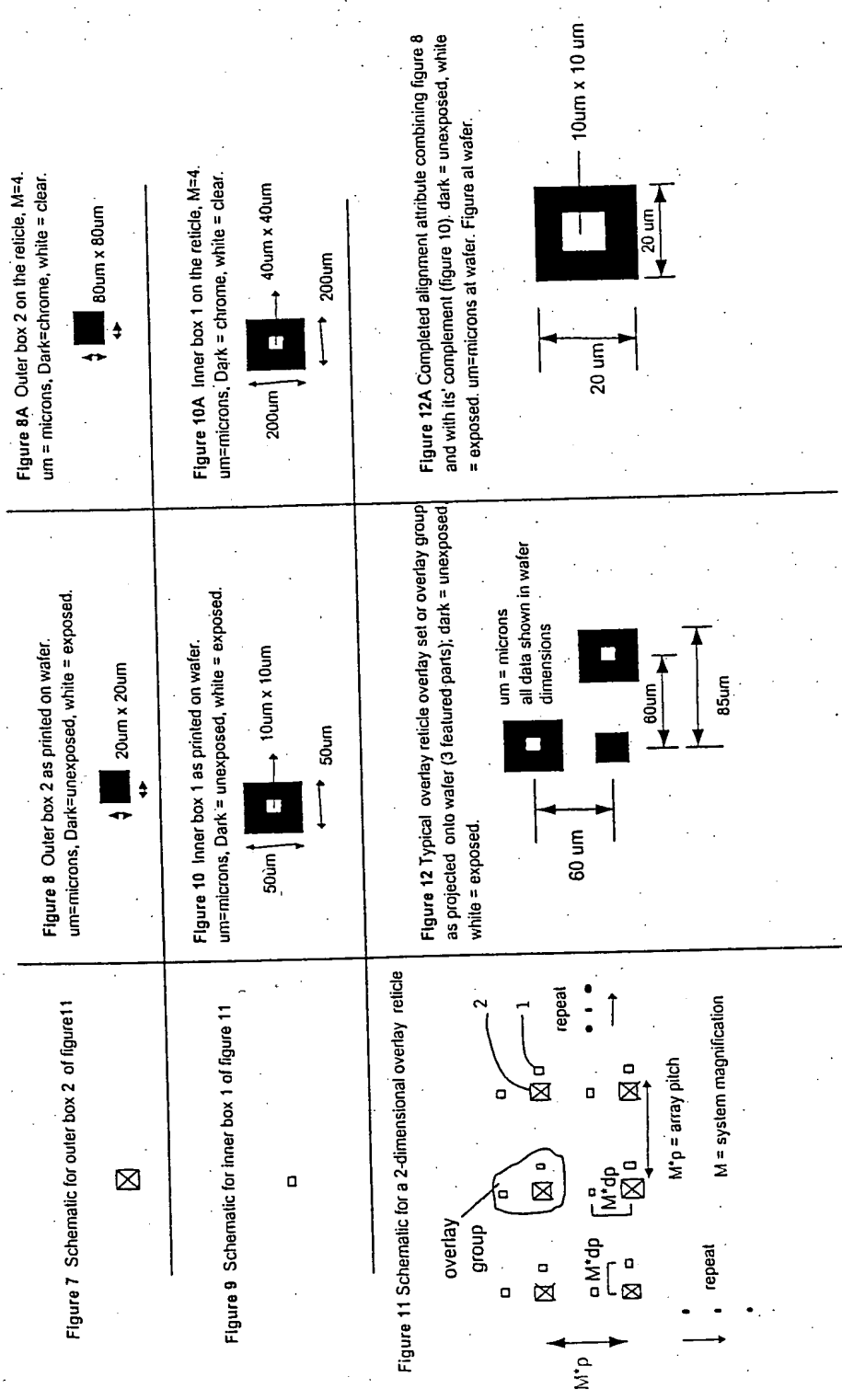


Figure 12A Completed alignment attribute combining figure 8 and with its complement (figure 10), dark = unexposed, white = exposed. um=microns at wafer. Figure at wafer.

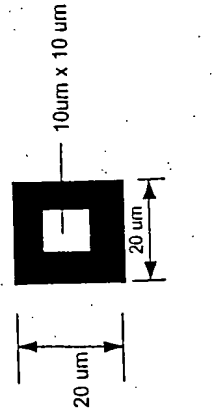


Figure 13 Overlay target patterns (x-overlap  
creating interlocking columns)

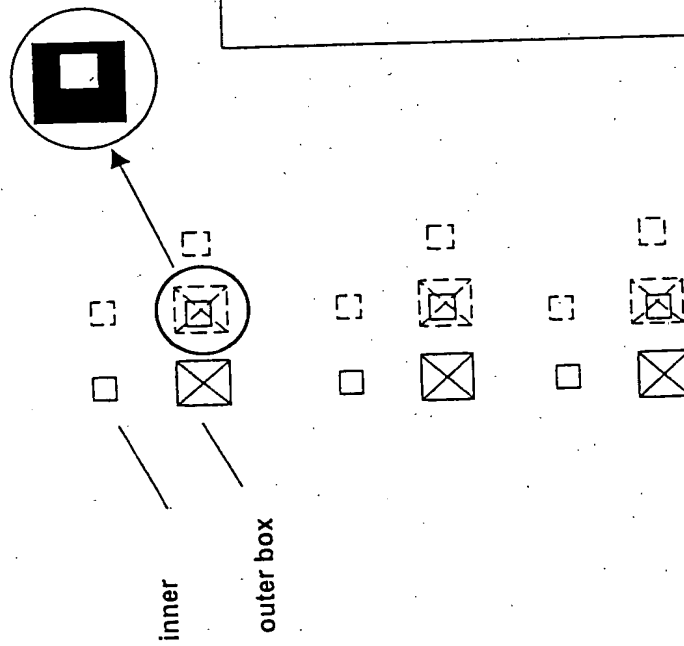
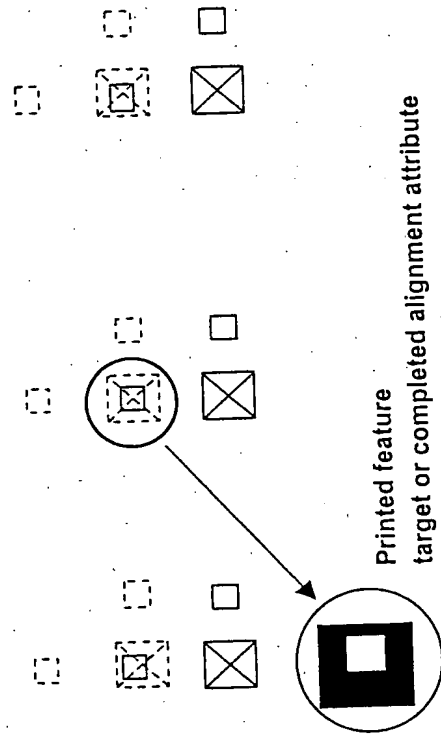


Figure 14 Overlay target patterns (y-  
overlap creating interlocking rows)



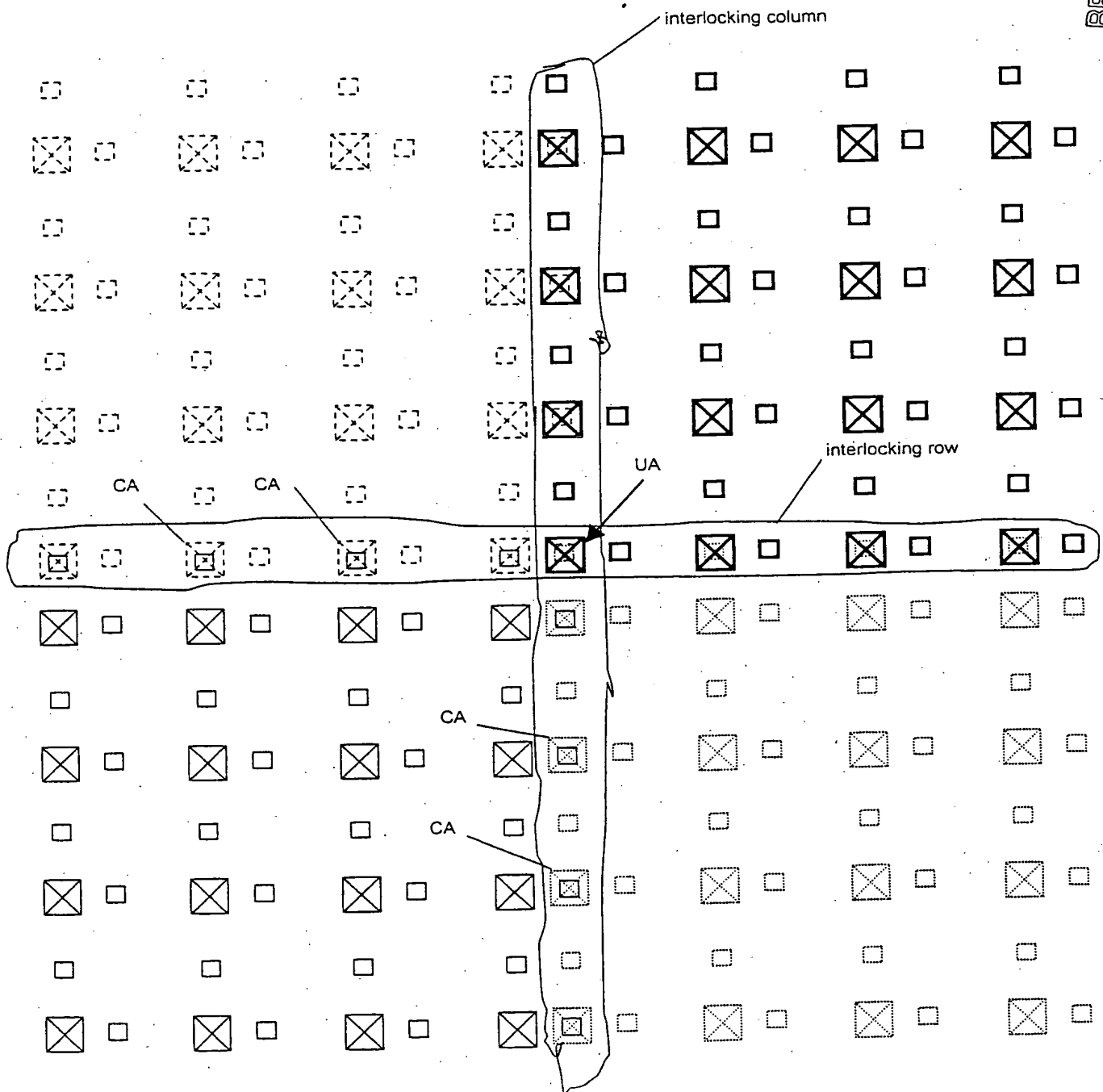


Figure 15 Preferred embodiment / process flow

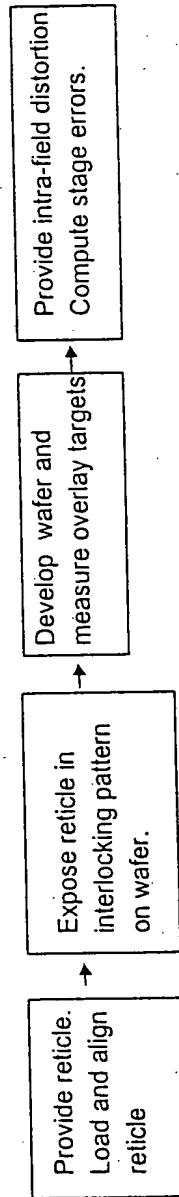


Figure 16 First variation of the preferred embodiment / process flow

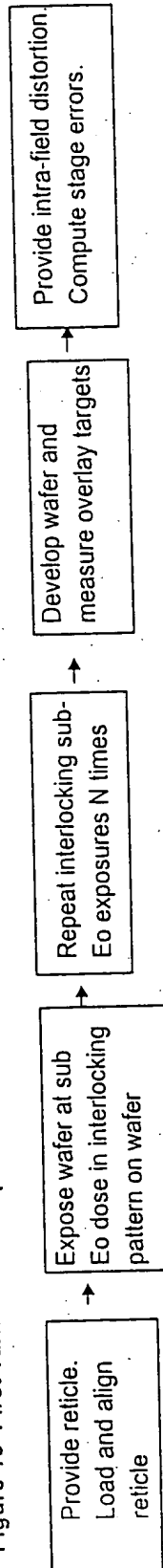


Figure 17 Second variation of the preferred embodiment / process flow

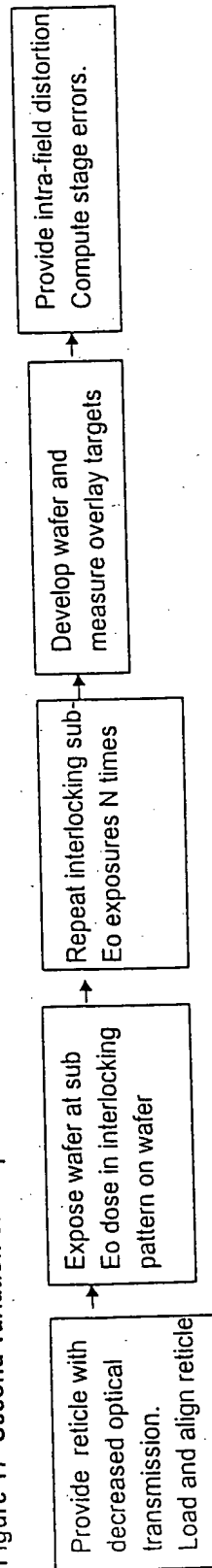


Figure 18 Common causes of overlay or placement error (Inter-field and Intra-field)

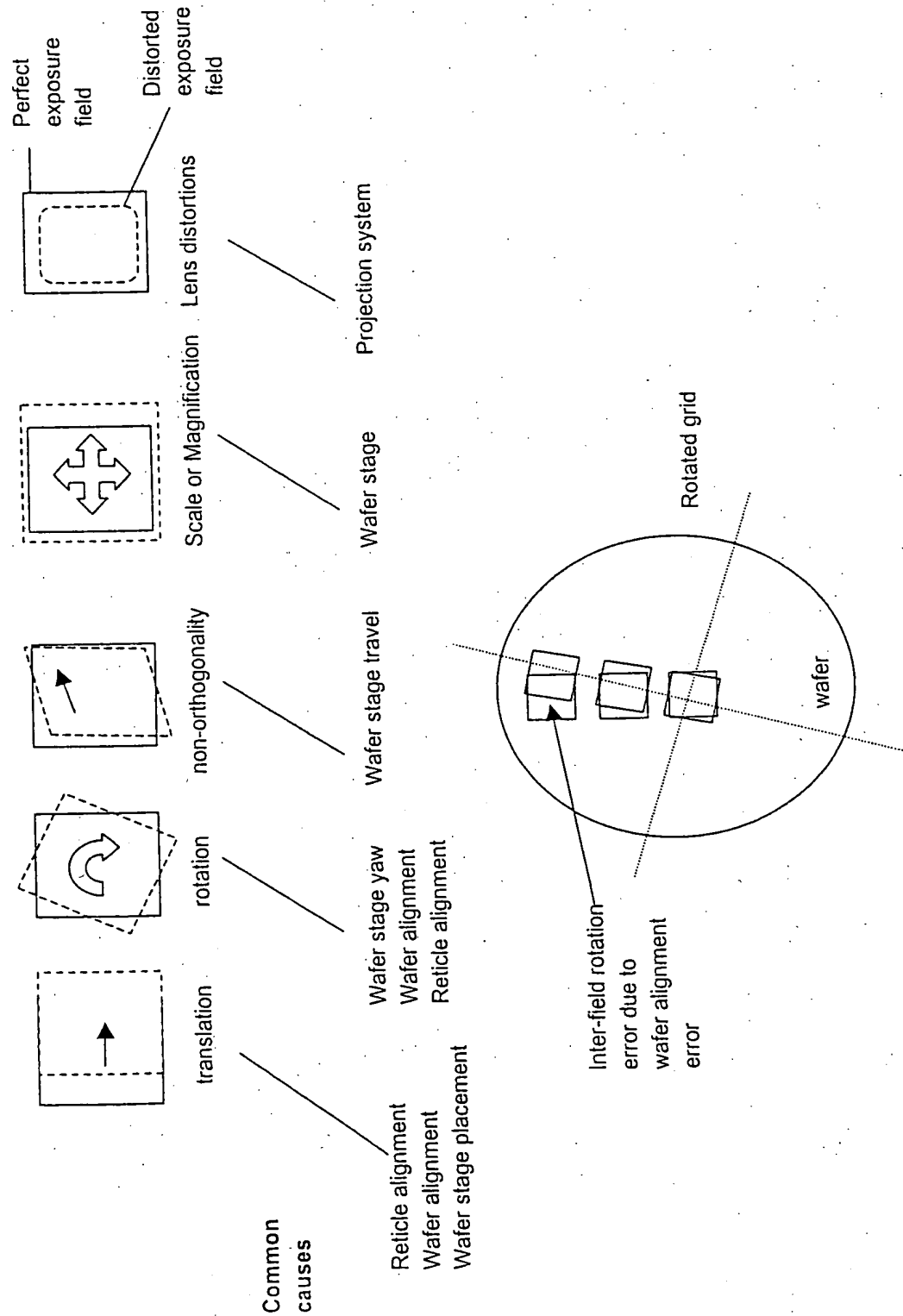


Figure 19 Photolithographic stepper or scanner system

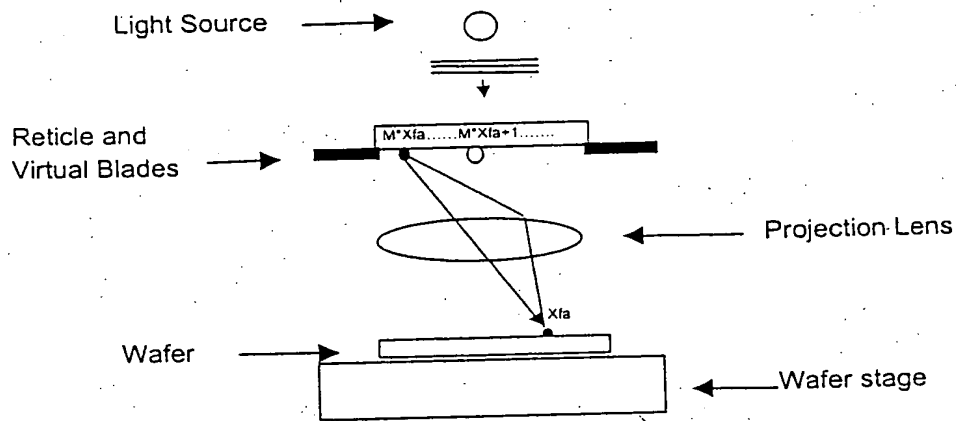


Figure 20 Inter-field and intra-field overlay error

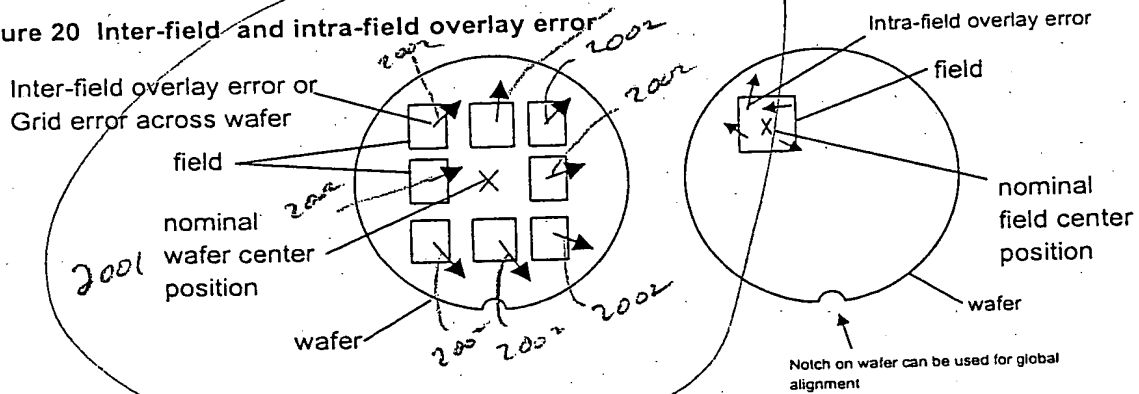


Figure 20A Interfield Yaw error

zero yaw = solid line fields  
non-zero yaw = dashed fields

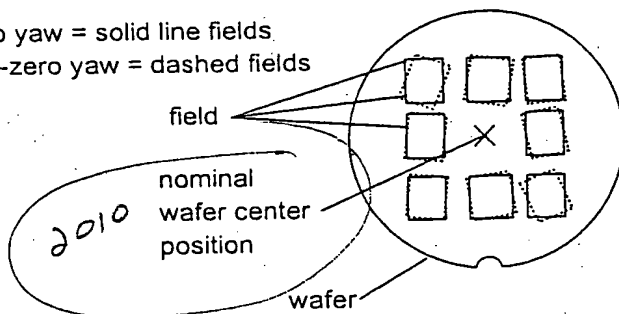




Figure 21 Preferred Embodiment Overlay reticle

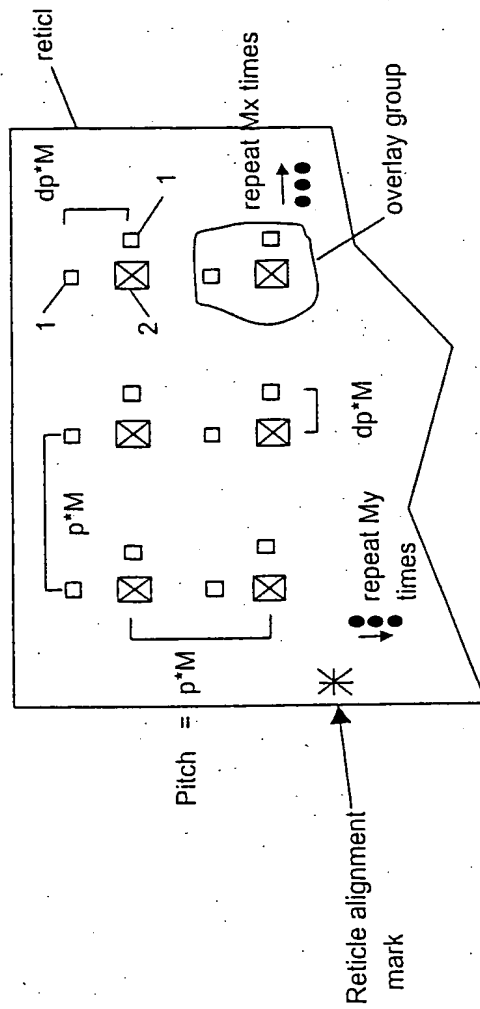


Figure 21B Side view of reticle of figure 21

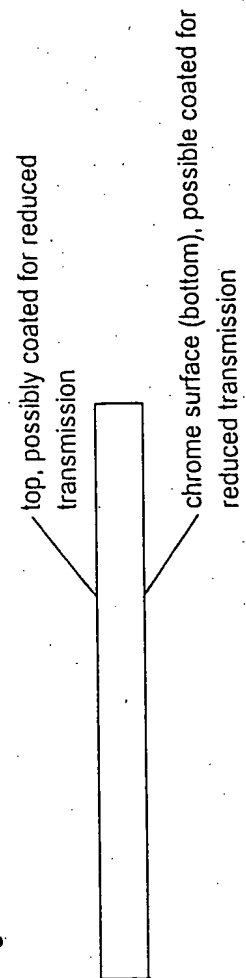


Figure 22 Prior art, stage matching and wafer stage error

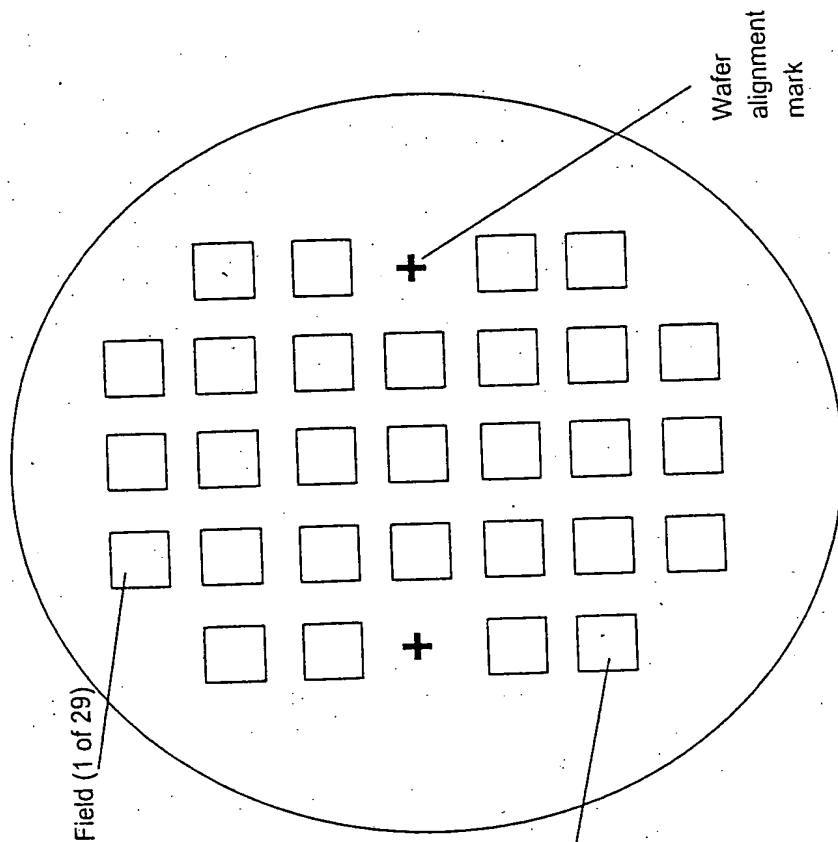


Figure 23  
 11 by 11 target array

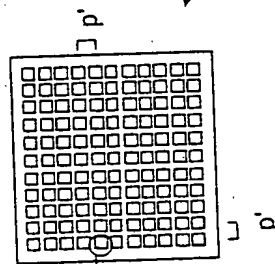


Figure 24  
 Targets

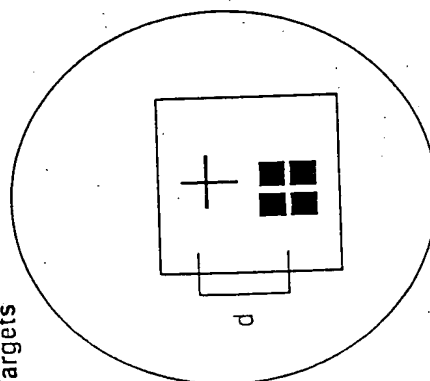


Figure 26 Tiled or interlocking wafer schematic  
 for self-referencing methodology

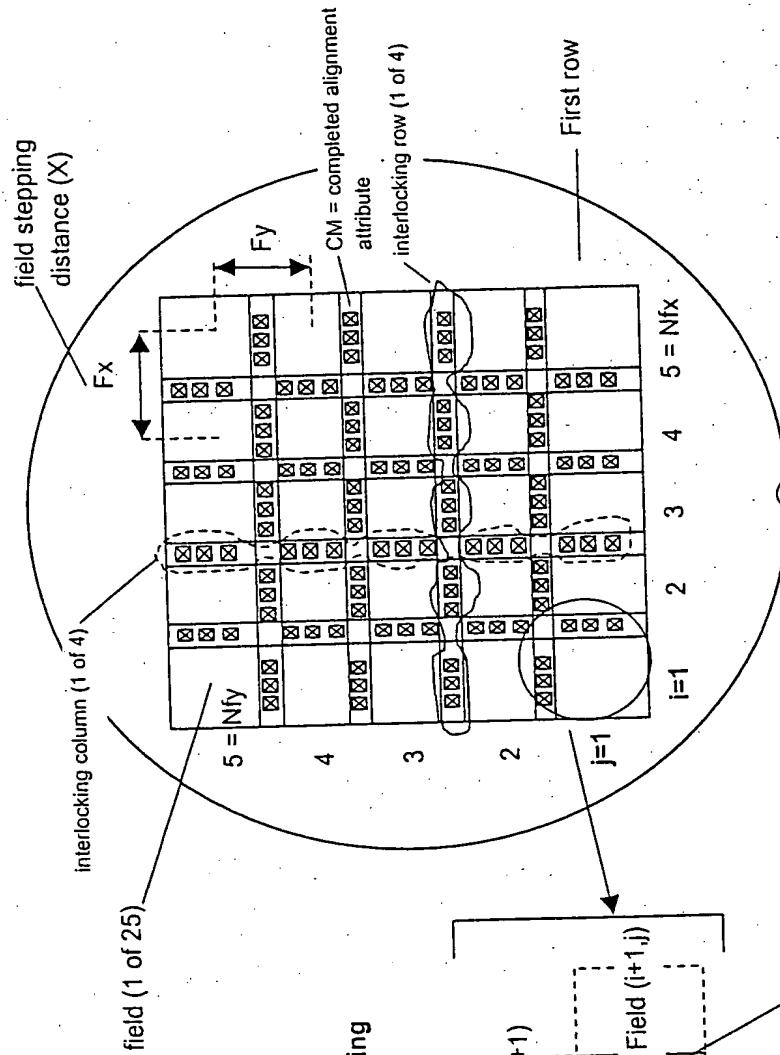


Figure 25 Typical overlapping regions showing  
 3 box-in-box overlay targets

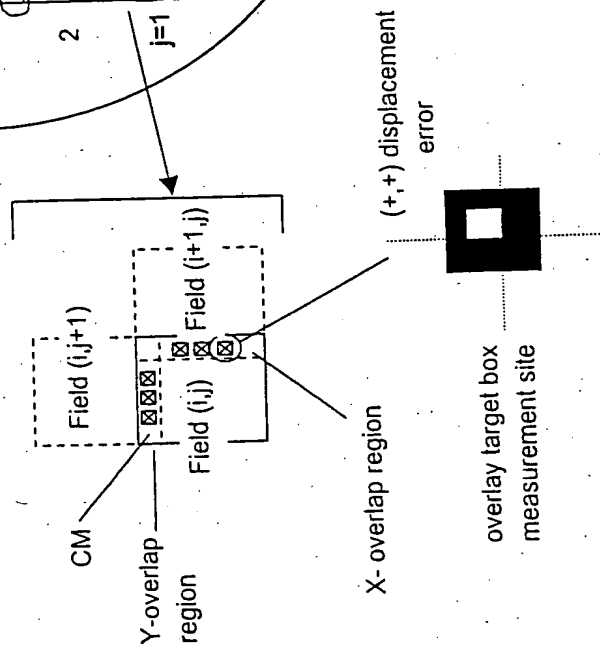


Figure 29 Rotation overlay vector plot

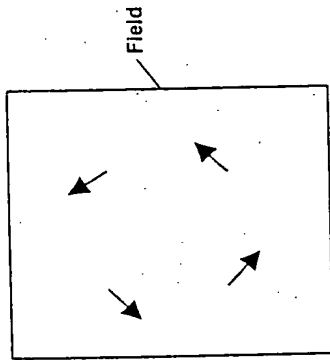


Figure 28 Translation overlay vector plot

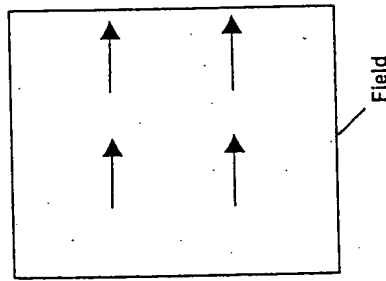
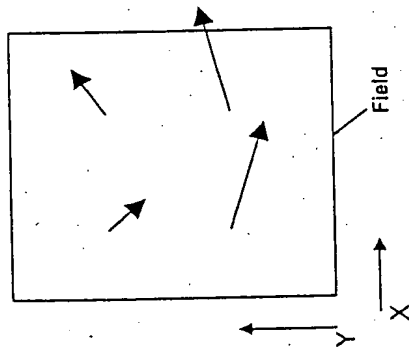


Figure 27 Overlay error vector plot



+

=

Figure 31 Perfectly centered Box-in-Box structure

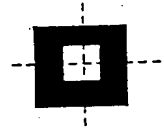


Figure 30 Overlay measurement



The vector represents the alignment offset distance between the box-in-box structure

Figure 32 Wafer alignment mark reticle

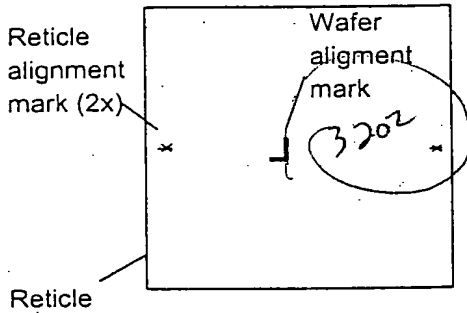


Figure 33 Inner box reticle

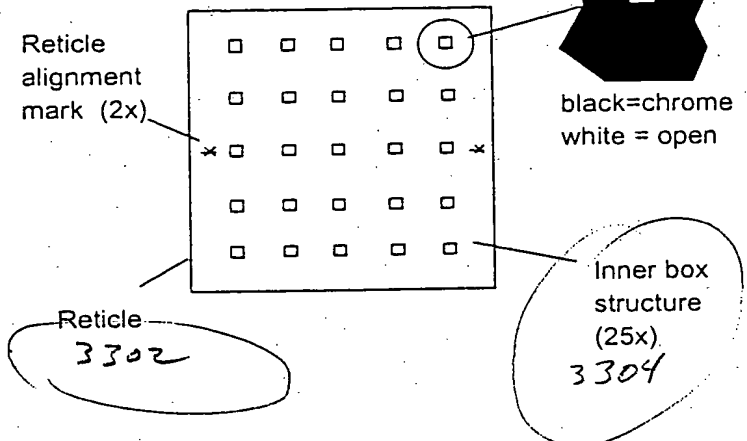


Figure 34 Reference wafer layout

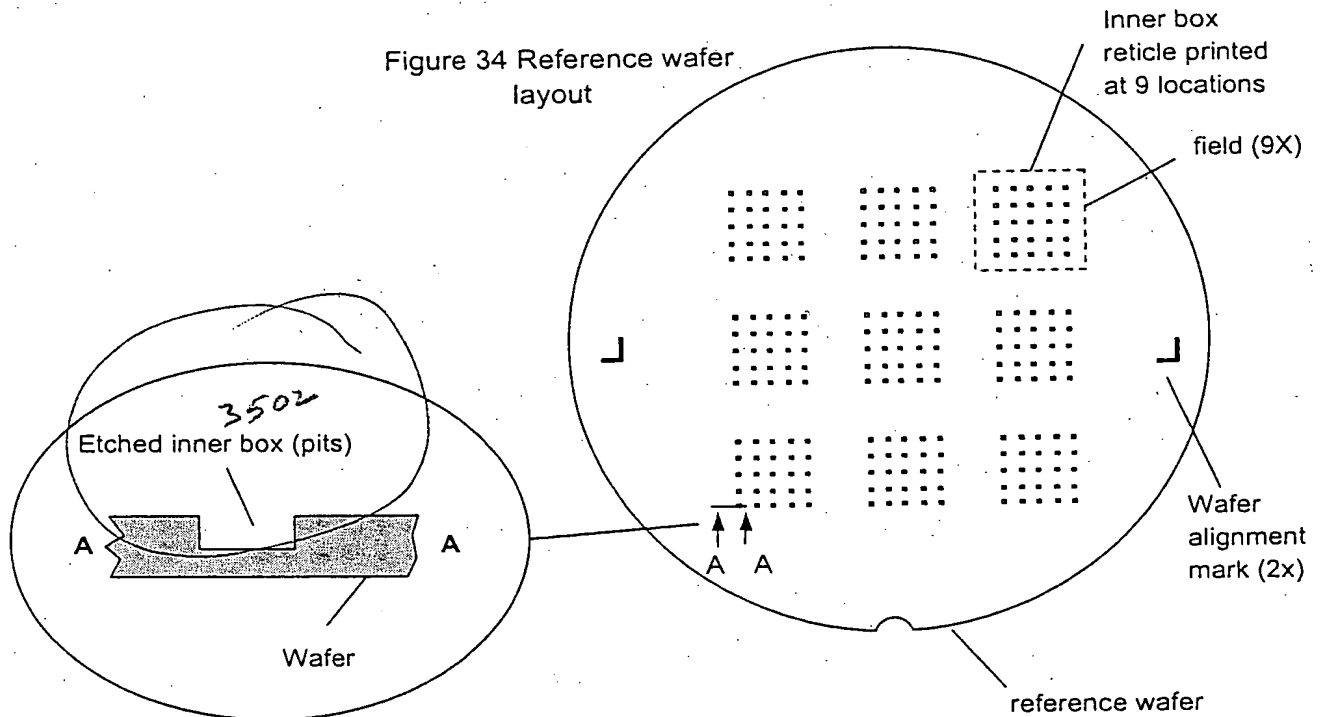


Figure 35 Cross section of inner box

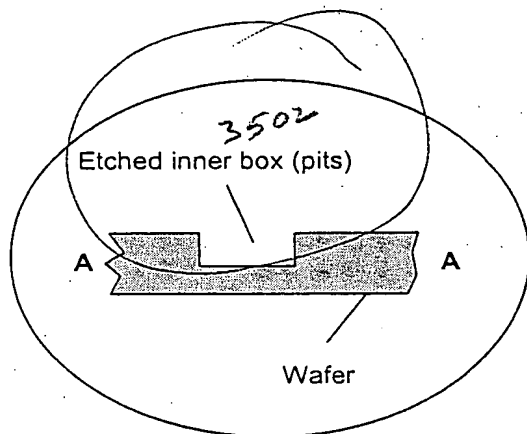


Figure 36 Outer box reticle schematic

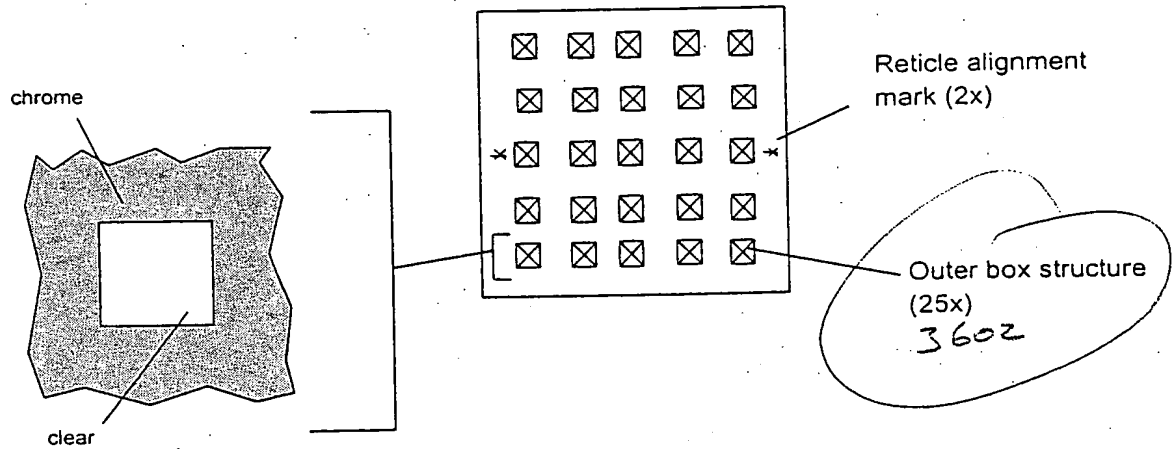


Figure 37 Outer box reticle detail

Figure 38 Developed reference wafer ready for overlay measurement

Figure 39 Box-in-Box cross-section AA

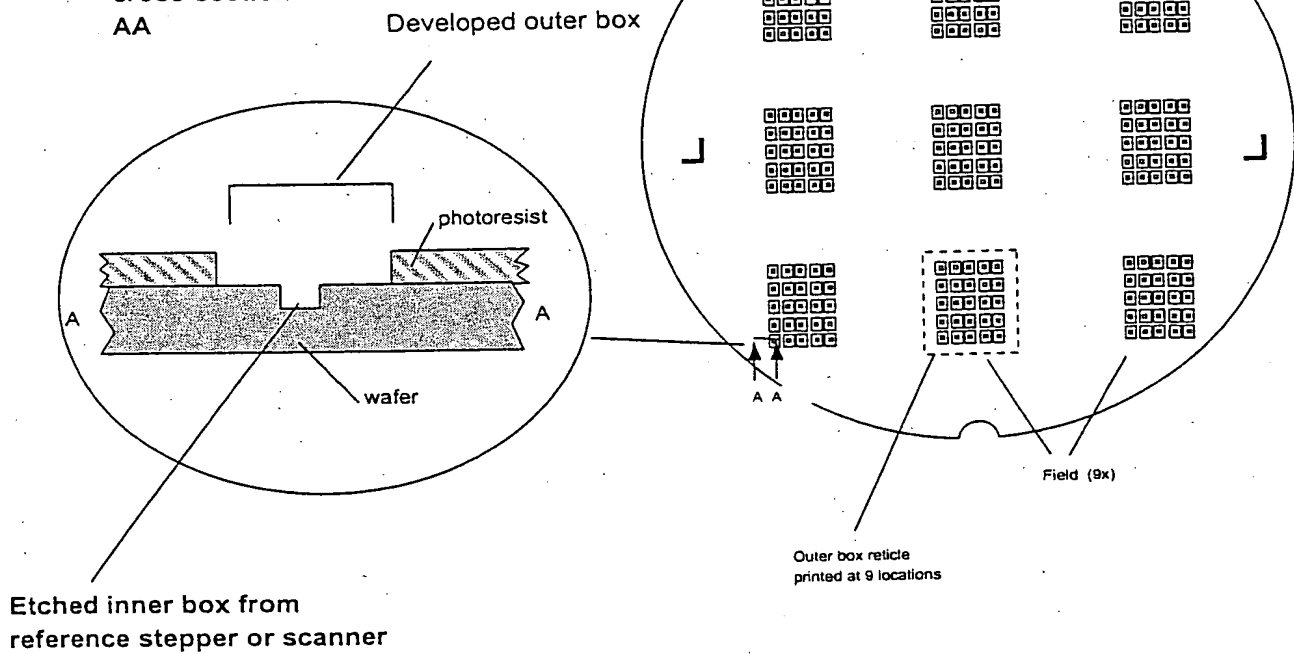


Figure 40 Inter-field and Intra-field indices

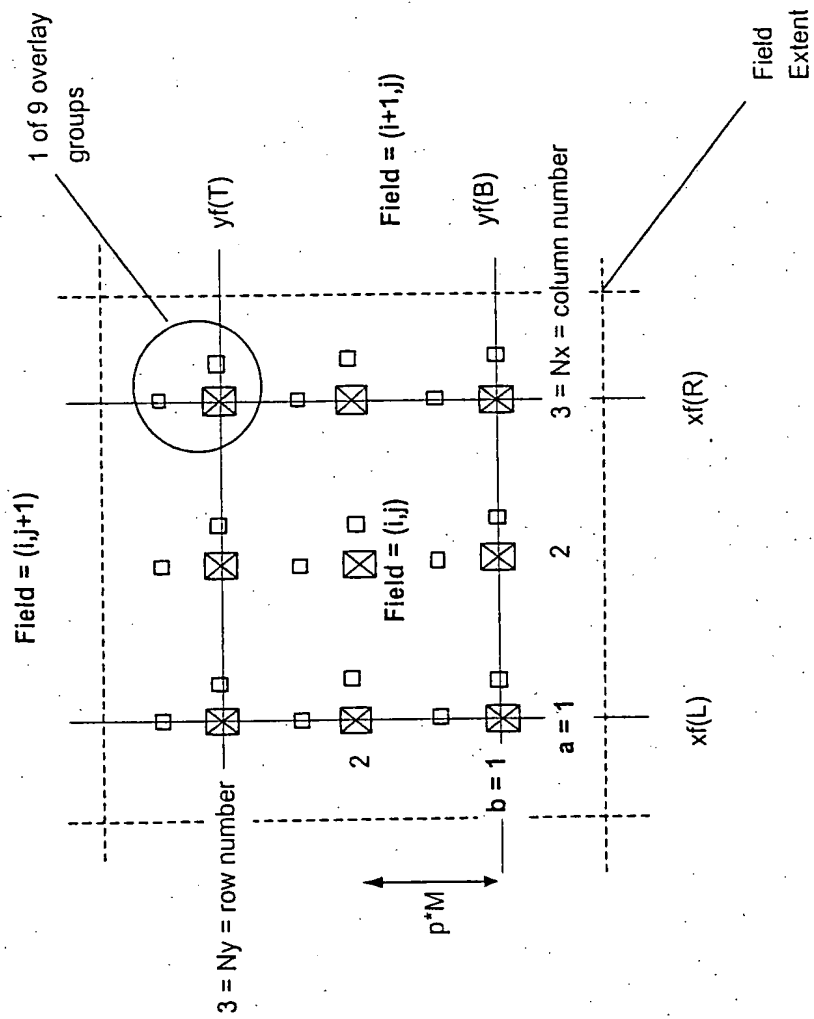


Figure 41 Alternate overlay reticle schematic with alternating inner and outer box structures on pitch  $p \times M$

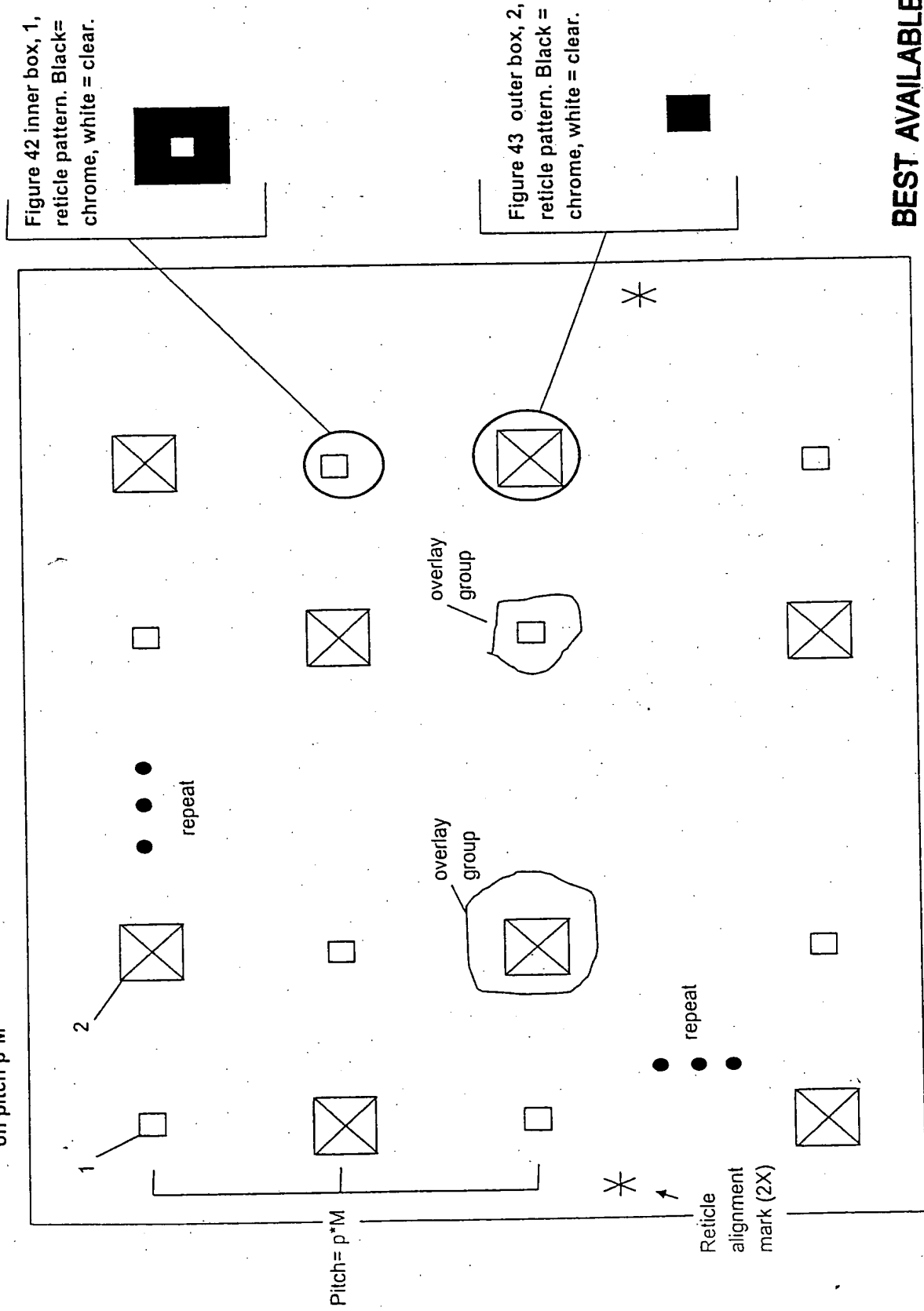




Figure 44 Partially exposed field and  
interlocking box-in-box structures along  
Field (i+1,j)'s left edge

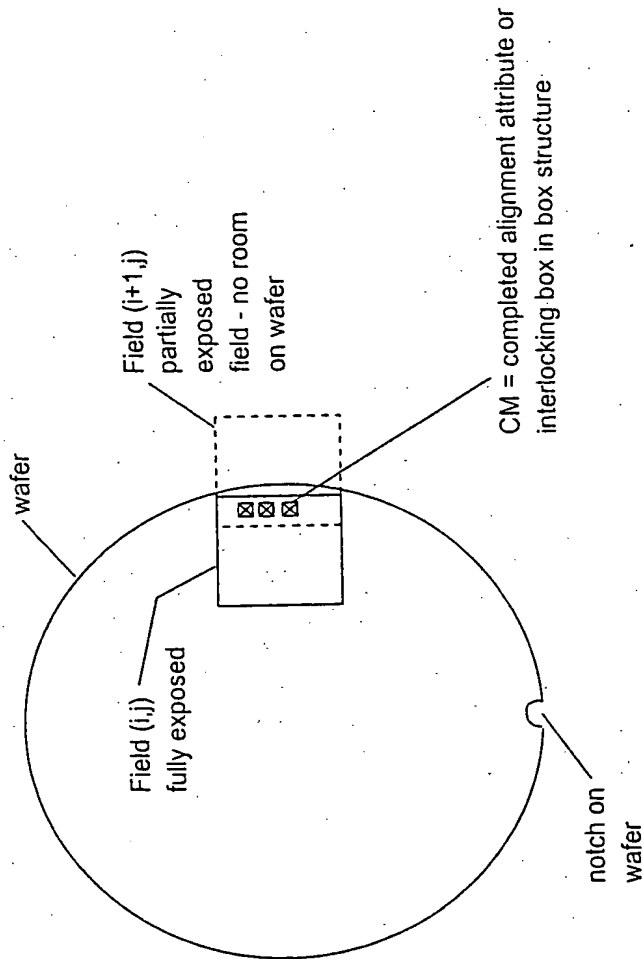


Figure 45 Simple reticle arrangement for  
accomplishing the method of this  
invention

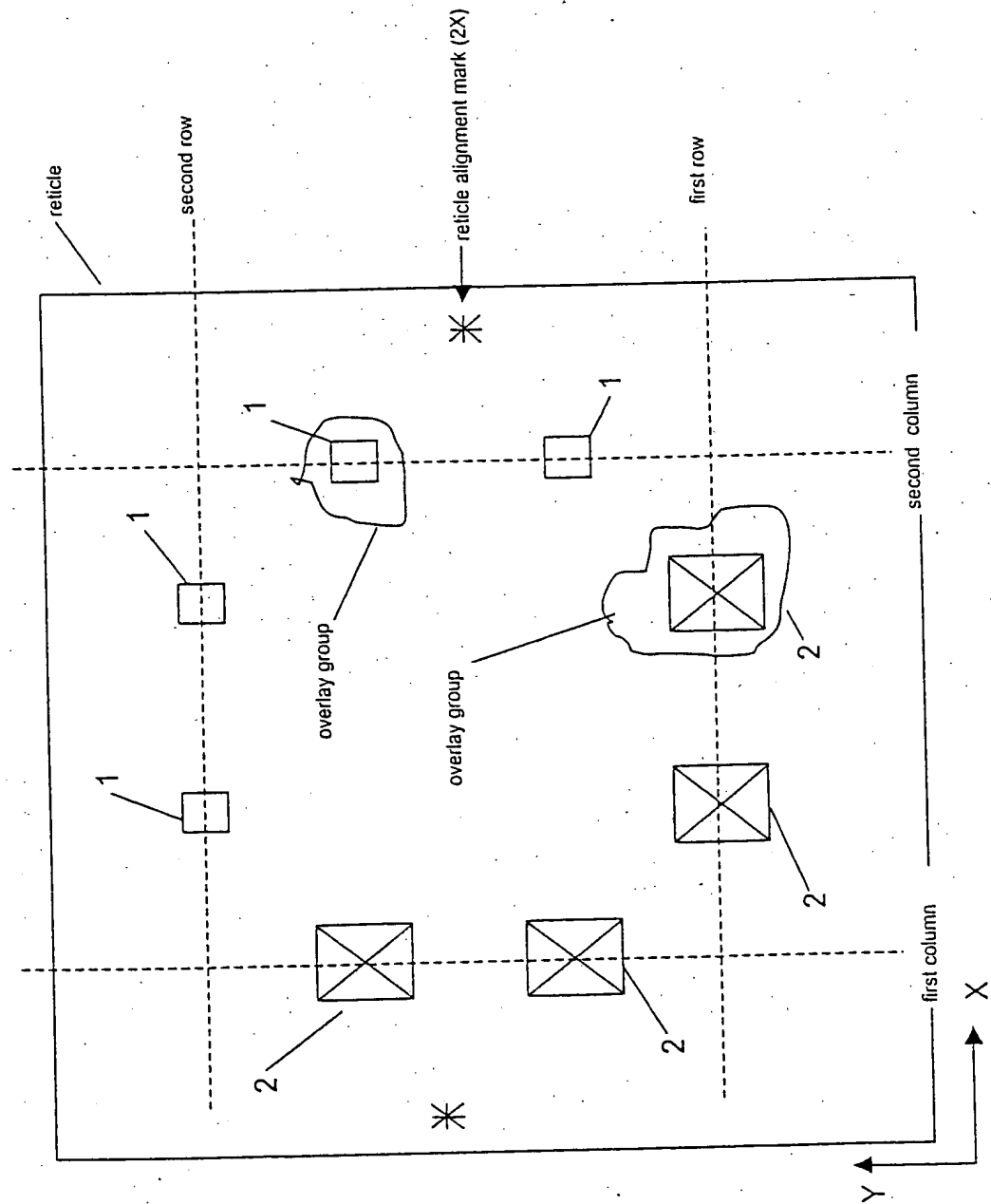


Figure 46 Final results of the method of this invention. Length units = microns, Yaw units = microradians. xG, yG = nominal field center position. dxG, dyG = offset of center of field. Qg = yaw of field. Fx, Fy = field stepping distance, srel = grid scale - intra-field scale (parts per million), D=wafer diameter.

machine id: DUVX5J						
	xG	yG	dxG	dyG	Qg	
D : 20000.000						
Fx : 20000.000						
Fy : 20000.000						
srel : -39.455						
-100000.000		0.000	-0.139	0.044	10.3	
-80000.000		0.000	0.223	-0.233	94.0	
-60000.000		0.000	0.498	0.004	-34.7	
.	.	.	.	.	.	.
.	.	.	.	.	.	.
.	.	.	.	.	.	.
60000.000	40000.000		0.099	-0.188	59.2	